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Culture Report 2 – Version 1

This work represents my individual work, and I have listed the sources that I have consulted. I have not received assistance that would violate the letter or spirit of the collaboration guidelines for this assignment.

Streamlining Model Deformation through Automation

Skeletal Deformation

"Example-Based Skeleton Extraction" is a paper by S. Schaefer and C. Yuksel dealing with improving a current method for deforming 3D models. After sculpting a model, artists deform 3D models to create many types of animated media. One method for deformation is to create a hierarchical skeleton that is attached to the model skin by weights. When the skeleton is transformed by the artist, the model's skin deforms along with the bones based on the skeleton's weight of influence. When using a skeletal deformation method, the artist must first design the model's skeleton and skin weights based on how they would like the model to articulate. While skeletal creation can often be done based on intuition, or conforming to an anatomical assumption about the model, this process can also be time consuming and it is not always obvious what skeletal structure is needed for the desired deformation. The same problem is true for when the artist must assign each surface of the model's mesh to be tied to the movement of the bones. Each point of the mesh is affected by the movement of different bones in the hierarchy, designated by the influence weight the bones have on that point of the surface. However, assigning those weights manually is time consuming and may not always produce the desired results because it can be difficult to anticipate how bone movements should affect different parts of the model.

This paper discusses a technique for automatically generating the skeleton hierarchy and skinning it to the model without the need for the artist to do it manually. Ideally, this should not only make preparing a model for deformation much easier, but if the method is good enough it should be able to improve the overall quality of deformations by making them consistent with what the artist expects. There are numerous existing approaches to automatically creating skeleton hierarchies and skin weights for 3D model deformation purposes. The approaches to skeletal generation often involve analyzing the geometry of a single pose of the model in order to make assumptions about how to divide the shape into a skeletal hierarchy. Approaches for skinning the model to a skeletal hierarchy often require preexisting skeletons already manipulated into example poses. This paper poses a new method for generating both the skeletal hierarchy and the skin weighting for a model by analyzing a set of poses which demonstrate examples of the desired deformation. Once the skeletal hierarchy and skin weighting is done for the model, the authors suggest that the data can be used in traditional modeling software to recreate the example poses as well as deform the model into any number of new poses which should reflect the desired anatomy of the model.

Proposed Method

In order to determine where bones are present in a model, given a set of example poses, surfaces are identified on the mesh. Then the transformations of surfaces between the static and

example poses are analyzed. Surfaces with similar transformations and connected topology are identified as belonging to the same bone. In this way the program groups different sets of surfaces to create an entire skeleton of bones which should represent areas of the model that move in unison.

Once the skeletal hierarchy is created, it must be skinned to the model in order to create deformations. Skin weights are assigned using similar methods to those already in existence which try and correlate the movement of different points on the mesh with the movement of different bones. Bones whose movement have a higher correlation to the movement of a particular area of skin are given a higher weight of influence to that area.

Some error can be introduced in this method when bones or areas of the model that are far apart tend to move in a similar fashion in many of the example poses. These are often caused by coincidence, but the process used to assign weights interprets it as meaning that they are somehow connected in their deformation. The paper states the importance of enforcing locality, or only allowing bones to have weight on nearby areas in the mesh, in order to reduce errors like these. This method enforces locality by removing the weight of a bone upon a part of the skin if that section of the skin is not contiguous with the area of the bone's highest influence.

The method proposed in the paper then uses information about which bones are weighted to which areas of the skin to determine how bones are connected. Simply put, if a skin has weights associated with multiple bones, it is assumed that those bones are connected near that location, and areas where bones tend to have equal weight indicates the location of the joint between those bones.

Method Results

The paper explains that using the process they developed, the authors were able to create a skeletal hierarchy and mesh skin weighting that allowed them to both closely replicate the original example poses and to model new poses that made sense with the anatomy of the models. This suggests that automatically generating skeletal hierarchy and skin weighting is a promising solution to simplifying the process of preparing 3D models for animation. While they identified some limitations of the solution for other deformation techniques, they expressed interest in developing a similar method of automatic generation using examples for other deformation methods.

Bibliography

Schaefer, Scott, and Cem Yuksel. "Example-Based Skeleton Extraction." ACM Digital Library,

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